Environmental Health Perspectives
Vol. 52, pp. 15-20, 1983

Acceptability of Human Risk

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This paper has three objectives: to explore the nature of the problem implicit in the term "risk acceptability," to examine the possible contributions of scientific information to risk standard-setting, and to argue that societal response is best guided by considerations of process rather than formal methods of analysis.

Most technological risks are not accepted but are imposed. There is also little reason to expect consensus among individuals on their tolerance of risk. Moreover, debates about risk levels are often at base debates over the adequacy of the institutions which manage the risks. Scientific information can contribute three broad types of analyses to risk-setting deliberations: contextual analysis, equity assessment, and public preference analysis.

More effective risk-setting decisions will involve attention to the process used, particularly in regard to the requirements of procedural justice and democratic responsibility.

Recent events have conspired to intensify the societal discussion of the level of risk appropriate for the control of technological hazards. The Supreme Court decision on the OSHA regulation to control the exposure of workers to benzene, for example, called for a determination of the presence of significant risks that could be reduced by the new standard, but not that the work environment be made risk-free (*1*). The recent Reagan Administration proposal to relax or eliminate 35 air quality or safety regulations (*2*) has raised anew the conflicts between an ailing economy and life-saving measures. The Three Mile Island accident of 1979 has provoked increased calls for a safety goal to which all nuclear regulation and licensing should aspire. Even the popular press has joined the fray, airing issues usually restricted to scientists and regulators.

These concerns have generally been characterized by the question: how safe is safe enough? In fact, this posing of the question has done much to muddle serious discussion of a complex problem. There are even those who assume that this question can and should be answered. Yet, setting risk standards involves thorny choices between enlarging benefits and reducing risks, healthier workplaces versus increased unemployment, and present versus future well-being. It is a situation ideally designed to breed indecision among beleaguered public officials whose training and experience are remote from the skills needed to resolve such issues.

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The Nature of the Problem

The term "risk acceptability" conveys the impression that society purposely accepts risks as the reasonable price for some beneficial technolgy or activity. For some special cases this may approach reality. Hang-gliding, race-car driving, mountain climbing, and even adultery are all high-risk activities in which the benefits are intrinsically entwined with the risks. These activities are exhilarating because they are dangerous. But most risks of concern are the undesired and oft unforeseen by-products of otherwise beneficial activities or technologies.

Acceptability is the concept that underlies judgments of safety. Lowrance, for example, argues that "... a thing is safe if its attendant risks are judged acceptable" (*3*). Setting aside for the moment the important questions as to how and by whom such judgments are made, probably no risk is acceptable if it can be readily reduced still further. To suggest otherwise is to invoke moral justification for trading practical constraints against human lives, a position that most risk guardians will wisely evade. The marketplace, then, is a poor guide to what risks are acceptable, as attested to by the century-long struggle by workers to reduce workplace risks. The occurrence of a past risk suggests more about the balance of political forces which pertained at that time than its acceptability to those who bore the risk.

What does it mean to accept a risk? Does the daily commuter who disdains seat belts accept the risks of automobile driving? Do the workers in textile plants accept the risk of cotton dust exposure? At this individual level, guidance can be found in the practices of informed consent formulated to protect subjects in human experiments. Here risk acceptance involves several important ingredients: the provision of full information concerning all potential risks, evidence that the subject understands the information, genuine freedom of choice for entering into the experiment, and the option to terminate one's participation at any time.

On the basis of the informational criterion alone, it is apparent that few risks meet the test of acceptance. Whereas some classes of risk (e.g., high probability/acute consequences) are undoubtedly better understood than others (e.g., low probability/chronic consequences), it is only a minority of risks for which the public approaches anything like full information and understanding. Nor is this irrational for, given the relentless parade of risks that confront the individual, limited information is undoubtedly a prerequisite for warding off hypochondria if not despair. There are also large classes of risks, including many of those most feared by the public, that are involuntary in nature. Even risks—such as workplace risks—traditionally labeled voluntary in nature probably fail to have much actual breadth of choice; workers, for example, tend to have restricted occupational and residential mobility and are not free to seek out less hazardous jobs, particularly when jobs are scarce. Suffice it to conclude, then, that most technological risks are not accepted; they are imposed, often without warning, information, or means of redress.

Since most risks are imposed on a less than fully informed risk-bearer, the response is more properly thought of as tolerance or acquiesence rather than acceptance. With limited choice and imperfect knowledge, the individual does not resist the imposition of the risk. As knowledge of the risk and range of choice grow, the individual will usually become more risk averse and the degree of risk acceptance will also increase. The area between the tolerated and the accepted risk is the latitude available to the risk guardian for standard-setting (Fig. 1). This structure of risk response is, of course, specific to a particular point of time and may be expected to change.

At the societal level, the issue is considerably still more complicated. There is little reason to expect consensus among individuals in their thresholds of tolerability and acceptability. In fact, some of the most difficult risks are those in which individual structures of risk tolerance tend to be divergent rather than convergent. Such appears to be the case, for example, with nuclear power where there are notable sex differences in the response to the hazard (*4, 5*). In such cases, the current tendency is to set the standard at the level deemed appropriate by the expert with an adjustment to reflect what Bill Rowe would term the risk's "squawk" factor (*6*). As often or not, this adjustment for public response fails to resolve the issue, leaving the risk guardian perplexed, frustrated, and irritated. And the means for communicating between anxious publics and well-intentioned experts fail, leaving the public distrustful of the expert and the expert convinced of the public's irrationality.

Increasingly it is apparent that judgments of appropriate risk levels are inherently problems of ethics and politics. Debates over risk are often, at root, debates over the adequacy and credibility of the institutions which manage the risk and not debates over the actual level of risk. Within the latitude available for risk-setting, the risk manager must weigh and trade off multiple objectives and conflicting values. In such decision situations, the preferred choices will not always be those with the lowest risk. Above all, the public wants to be assured that these decisions are made fairly and with a strong commitment to the safety and well-being of the public. With this in mind, it is appropriate to consider current interest in a

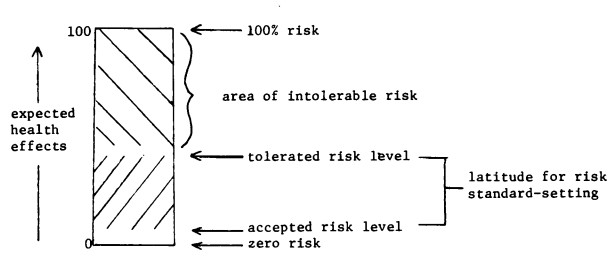

FIGURE 1. Schematic diagram of individual response to risk.

comprehensive risk standard and the possible contributions of scientific knowledge.

The Search for an Analytic Fix

There is a great temptation to tidy up this confusing mish-mash of risk decisions through some common yardstick and consistent standard for risk imposition. Several means have been proposed: some see in the historical pattern of risk occurrence evidence that society has arrived at a recurring balance between risk and benefit (*7*). Others see the need for a consistent quantitative level of risk to serve as the basis for all regulation (*8*). Still others would have cost effectiveness serve as the guiding principle in responding to risk across technologies (*9*).

This search for an analytic fix for the risk acceptability problem is misguided. Worse still, it reveals a profound misunderstanding of the nature of the problem. First, it wrongly assumes that one risk is like any other, whereas it is patently clear that risks are multidimensional phenomena that fall into complex groupings. Death by cancer is not the same as death by accident; catastrophic risks are more feared and carry greater social toll than smaller fatality risks; imposed risks are unlike accepted risks. Research at Clark University over the past five years has identified some 19 hazard attributes which, when factor analyzed for some 93 technological hazards, fall into some five major factors which differentiate such hazards (*10*). When compared with studies of public response to the same hazards conducted by Paul Slovic and colleagues at Decision Research, Inc. (*11*), a remarkably close correspondence emerges between the structure of technological hazards and the nature of public response, providing hope that an overall taxonomy of such hazards is possible which will have strong public policy relevance. But it makes clear that regulatory approaches to risk will need to be plural, taking account of major important differences among risks.

Second, decisions on risk levels do not occur in isolation from other social objectives and constraints. Each risk decision, then, tends to be technology- or even situation-specific (*12*). The particular set of values, scientific information, cost considerations, and safety opportunities differ from one risk to another and from one time to another for the same risk. Moreover, different regulatory agencies have different legislative mandates and program priorities for the same risks. Sound decisions on risk levels and distribution, therefore, will and should show substantial variation among even similar risks. However untidy that may appear to some, it is an inescapable reality of responsible and rational risk management, a conclusion, by the way, shared by two recent appraisals of the risk acceptability issue (*12, 13*).

The Contribution of Scientific Information

The role of the expert in judgments on risk levels and distributions is to provide information and analyses to inform the decision process. Such formal analyses, however, should not preempt the established process which provides participatory or consultative roles for interested parties. The purpose of such analyses is to support an expert judgment for a draft standard which will then be tested in the political process. Three broad types of analyses—contextual analysis, equity analysis, and public preference analysis—are essential for sound decisions (Table 1).

Contextual Analysis

The risk under consideration should be placed in appropriate contexts to shed light on its social meaning. Five contexts or comparisons are paramount: the risk as compared with natural background, the risk compared with other risks prevalent in society, the risk in the context of the magnitude of associated benefits, the costs of risk reduction, and the risks of available substitutes (if needed).

Table 1. Expert assessment for judging risk intolerability.

Contextual analysis	Equity analysis	Public preference analysis
Risks in the context of:	Distribution of risks, benefits, and control costs over:	Public risk reduction preferences as indicated by:
Natural background levels	Workers and publics	Incurred risk inference
Other extant risks	Generations	Legal legacy inference
Magnitude of benefits	Backyards	Expressed values
Costs of control	Social groups	
Risks of available substitutes		

In the first, the risk is compared with natural background levels of exposure. This comparison suggests the increment to risk afforded by the use of some technology or activity. Large departures are obvious sources of concern, whereas those undetectable in variations in natural exposure merit much less concern. Such analyses have been helpful in the field of radiation control.

The second context is the risk compared with other risks prevalent in society, often with the assumption that risk levels should be balanced. Typically, the comparisons are with similar technologies, other stages of a fuel or production cycle, or risks previously determined to be tolerable by a particular risk guardian. In the British chemical industry, for example, if a given risk contributes more than 4.0 to the fatal accident frequency rate—the number of fatal accidents in a group of 1000 men in a working lifetime (100 million hours)—risk reduction is undertaken. Two well-known comparisons in the energy area are those of the Rasmussen Report (*14*) and the Inhaber analysis (*15*). The issue in such comparisons is whether or not the choice of contextual risks clarifies or obfuscates the risk under consideration. To compare reactor risks with the chance of being hit by a meteor, radioactive waste repository risks with the danger of lightning, or nuclear power with automobile fatalities does little to clarify public choice considerations. There is, however, considerable value, as Gori has argued (*16*), to risk comparisons within a functional class of products needed to sustain a modern society, where benefit levels and uses tend to be similar.

Perhaps the most common form of contextual analysis is a comparison of risks and benefits. This method recognizes some level of risk above zero as necessary and balances the benefits of the activity or technology against the risk to determine how much risk reduction should be undertaken. The quality of such analyses varies widely, depending upon such factors as the messiness of the problem, the skill of the analyst, the way in which the analytic question is posed, the existence of appropriate techniques, and the analyst's ability to fashion new techniques (*17*). Benefit analysis is particularly underdeveloped, with considerable difficulty often apparent in determining even whether a particular outcome is beneficial or harmful (e.g., increased electricity consumption). While useful as one type of decision information, by itself risk/benefit analysis cannot solve, and may obscure, important policy and ethical issues (e.g., distributive justice).

A third type of contextual analysis is the cost effectiveness of risk reduction. The question at stake is how much society wishes to spend to avoid a particular consequence. It is well known that such expenditures vary widely; in 1972, for example, Sinclair estimated that in Britain \$2000 was spent to save an employee's life in agriculture, \$200,000 in steel handling, and \$5 million in the pharmaceuticals industry (*18*). In a search for an analytic fix, Wilson has suggested that a "risk tax" of \$1 million per life be used to achieve maximum overall reduction in the array of risks facing society (*19*). But risk levels can also be set by changes in the slope of the curve in risk reduction efficiency for any given risk (Fig. 2).

A final form of contextual analysis involves the examination of risks of available substitutes. Actions designed to reduce risks sometimes create new and perhaps larger risks, such as increased coal-burning when nuclear plants are shut down for safety reasons or the use of TRIS-treated pajamas as a substitute for flammable materials. Judgments on tolerable levels of risk imposition must consider the risks likely to accrue from increased use of substitute products or technologies.

Equity Analysis

Equity analysis is a second—and oft-neglected—need in scientific analysis to support risk decision-making. Characteristically those who enjoy the benefits of a technology are not the same as those who bear the risks. Risks are rarely distributed evenly throughout society and they are sometimes exported to future generations. Attempts to control risks may benefit different groups than those who pay the control costs. While scientific analysis cannot and should not, of course, resolve equity issues, it can lay bare the distributional inequities and value problems.

Four types of inequity merit analysis. First is potential inequity between workers and publics.

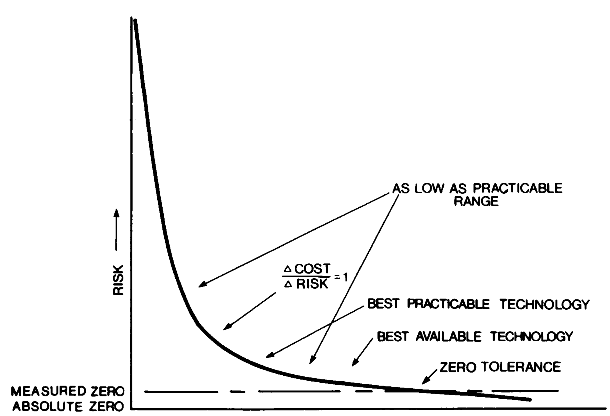

FIGURE 2. Social criteria for risk reduction. After Rowe (*6*).

Higher exposure standards for workers are tolerated in this society and others than those permitted for publics on the basis of questionable moral assumptions. The societal risk from some problems—the toxic waste cleanup comes to mind—can easily be displaced to workers who need jobs. Second is the inequity over generations. Increasingly, there is concern over the export of risks to the future, particularly where the effects may be irreversible. Ozone depletion and radioactive waste disposal are prominent examples. Third is the geographical inequity often referred to as the backyards problem. Traditionally, our society has located noxious facilities and hazardous activities in the backyards of vulnerable and politically powerless peoples. Finally, a more general analysis is required to assess impacts across social groups, including native peoples, minorities, and social classes.

Public Preference Analysis

The third major type of scientific information needed for judgments on risk levels is an assessment of public preferences for risk reduction. The purpose of such inquiry is not, it should be emphasized, to substitute for the direct expression by the public of its wishes but rather to anticipate what preferences are likely to be and to indicate where there are large departures in expert and lay public assessments of risk.

Three major types of information concerning public preferences are useful. Inferences from incurred risks, commonly described as "revealed preferences," use statistical risk and economics data for risk/benefits trade offs acceptable to the public. The assumptions are that, by trial and error, society has arrived at a nearly optimal balance between risks and benefits, and that prevailing social and economic relationships are just and consonant with public values. Both are in doubt so the results need to be compared with other public preference indicators. Inference from legal legacy looks to the past accumulation of regulatory decisions and court cases for guidance to appropriate standard-setting. Finally, *expressed* preferences involve directly eliciting risk reduction preferences from the public itself. Considerable progress has occurred in this research, suggesting that lay publics are basically rational on risk questions, order risks similarly to experts but systematically overestimate well-publicized and dramatic risks and underestimate chronic, dispersed risks, and are very risk averse for risks with catastrophic potential.

By putting risks into appropriate contexts, assessing equity issues, and anticipating likely public preferences, the scientist can provide information needed for risk decision-making. However, the key to effective risk decisions lies in the process and institutions responsible for the judgments which emerge, an issue to which we now turn.

Towards an Effective Decision Process

Viable decisions on risk levels and distribution require a process consistent with Western democratic theory and directive to the risk guardian. Since the public cannot hope to inform itself and participate in the innumerable decisions on risk, it delegates discretion to the legislators who pass laws and to the regulators who implement them. Doubts as to the credibility of these institutions and processes have provoked much of the current debate over risk decision-making. If and when that credibility is recovered, "how safe is safe enough" will cease to be the subject of societal debate. In the meantime, extraordinary efforts will be required for the recovery of trust and for socially acceptable decisions on risks.

In a democracy, what the risk guardian ideally wants to know to make value-laden decisions is what would public preferences be in the context of informed consent, where interests have become clear, issues dissected and debated, opposing views confronted, and individuals free to choose. It is a hypothetical state, of course, for a modern democracy cannot realize such requirements for risk or for any other public issue. All such decisions will inevitably involve choices between the interests of society and the prerogatives of the individual. Public officials make such decisions not in grand master strokes, but in piecemeal decisions which emerge in a series of moves made over time. Customarily we think of the goal of such decisions as lying in realization of the "public interest," a concept itself the subject of disagreement and confusion (*20*).

A credible process finds its starting point in the recognition that power relationships in risk decision arenas are assymetrical. The creators of risk nearly always have superior knowledge and resources to promote the expansion of potentially hazardous technologies. A variety of forces incline many scientists and risk guardians in the direction of risk creators. Those who fear the risk, by contrast, have few resources, limited and usually tardy access to the decision process. It is this structure of decision-making which is most at stake in the current wars over risk tolerability.

A viable process for risk decisions is one which recognizes the requirements of procedural justice and democratic responsibility. The details of such a process are the subject for a lengthier discussion; suffice it to note here five major consdierations for such a process.

(1) Decisions on risk are rarely made in isolation but are part of broader societal choices on the use and expansion of particular technologies and activities. "Best solutions" involve choices which take account of competing social values and multiple goals. The appropriate role of the scientist lies in the estimation and measurement of risk and the creation of information needed to assess its meaning, but not in determining its preferred level or distribution.

(2) Attempts to find an analytic fix for the risk tolerability problem are misguided. Risk standard-setting should begin with the recognition that such standards should be plural in nature, varying in level and distribution with magnitudes of benefits, equity consideration, opportunities for risk reduction, availability of less risky alternatives, public preferences for risk reduction, and other considerations.

(3) Risks cannot be made fully voluntary if society is to realize the potential good associated with existing and new technologies. The emphasis in risk management should be on avoiding rather than mitigating risk, in making unavoidable risks as voluntary as is feasible, and in compensating the bearers of unavoidable risks from beneficiaries where possible.

(4) Since risks tend to be imposed rather than accepted, the burden of proof should be on the risk creator to demonstrate the need for the technology and the absence of the risk.

(5) Fairness in risk imposition is best achieved by the active participation of risk bearers in their own behalf in decisions as to the tolerability of particular risk levels and allocations. Risk bearers should not be dependencies in the decision process, but require their own technical capability, right to negotiation, and legitimacy in the process. They also have the right to full information as to the risks which will be imposed upon them.

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